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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/666,509	09/19/2003	Lakshmipathi Sondur	111027-134390	9185

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EXAMINER

MULL, FRED H

ART UNIT	PAPER NUMBER
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3662

DATE MAILED: 08/27/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/666,509

Applicant(s)

SONDUR, LAKSHMIPATHI

Examiner

Fred H. Mull

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 24 May 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-52 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-11 and 13-52 is/are rejected.
- 7) ☒ Claim(s) 12 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 12-9-2003.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "110" has been used to designate both the RF unit and the signal processing unit. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Corresponding corrections should also be made to the specification.

Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Specification

Applicant is reminded of the proper language and format for an abstract of the disclosure.

A patent abstract is a concise statement of the technical disclosure of the patent and should include that which is new in the art to which the invention pertains. The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The

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form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.

The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

2. The abstract of the disclosure is objected to because it fails to include that which is new in the art to which the invention pertains. The current abstract is a broad statement that would be a more appropriate as a "Field of the Invention" statement. There are wireless signal processing method and apparatuses, including signal direction of arrival estimation, that are known. Applicant's invention is more specific than that. Additionally, the abstract of the disclosure is objected to because the term "herein" is legal phraseology, which should be avoided in the abstract. Correction is required. See MPEP § 608.01(b).

Claim Objections

3. Claim(s) 12 is objected to under 37 CFR 1.75. The claim recites the limitation "the first signal" in line 7. There is insufficient antecedent basis for this limitation in the claim. To be consistent with claim 11, it should read --the first of the signals--. Correction is required.

4. Claim(s) 13 is objected to under 37 CFR 1.75. The claim recites the limitation "the second plurality of directions or arrivals" in line 5. There is insufficient antecedent basis for this limitation in the claim. The claim should either (a) read "the first plurality ..." or (b) be dependent on claim 12 rather than

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claim 11. Correction is required. In order to further examine this claim, situation (a) will be assumed.

5. Claim(s) 31 is objected to under 37 CFR 1.75. The claim recites the limitation "the first received signal" in line 8. There is insufficient antecedent basis for this limitation in the claim. This should read --a first received signal --. Correction is required.

6. Claim(s) 32 is objected to under 37 CFR 1.75. The claim recites the limitation "the first signal" in line 8. There is insufficient antecedent basis for this limitation in the claim. To be consistent with claim 31, it should read --the first received signal--. Correction is required.

7. Claim(s) 33 is objected to under 37 CFR 1.75. The claim recites the limitation "the second plurality of directions or arrivals" in line 6. There is insufficient antecedent basis for this limitation in the claim. The claim should either (a) read "the first plurality ..." or (b) be dependent on claim 32 rather than claim 31. Correction is required. In order to further examine this claim, situation (a) will be assumed.

8. Claim(s) 45 is objected to under 37 CFR 1.75. The claim recites the limitation "the first received signal" in line 10. There is insufficient antecedent basis for this limitation in the claim. This should read --a first received signal --. Correction is required.

9. Claim(s) 46 is objected to under 37 CFR 1.75. The claim recites the limitation "the first signal" in line 7. There is insufficient antecedent basis for this

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limitation in the claim. To be consistent with claim 31, it should read --the first received signal--. Correction is required.

10. Claim 47 is/are objected to under 37 CFR 1.75. The claim recites the limitation "the second plurality of directions or arrivals" in line 5. There is insufficient antecedent basis for this limitation in the claim. The claim should either (a) read "the first plurality ..." or (b) be dependent on claim 46 rather than claim 45. Correction is required. In order to further examine this claim, situation (a) will be assumed.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

11. Claims 1-8, 21-28, 41, 42, and 49-50 are rejected under 35 U.S.C. 102(b) as being anticipated by IDS document Schmidt.

In regard to claims 1, 21, 41, and 49-50, Schmidt discloses receiving a first plurality of signals wirelessly transmitted by a plurality of signal sources, employing a plurality of sensors (p. 276, Introduction, 1st ¶); taking a first sample of the received signals sensed by the sensors; constructing a first received signal vector (X, equation (1)) based on the first sample, employing a first plurality of signal directional vectors (A); and determining a first plurality of directions of

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arrival for the signals based at least in part on a relationship between the first received signal vector and the first plurality of signal directional vectors (p. 277, 1st col., 2nd ¶; p. 277, 2nd col., The Algorithm, 1st ¶; p. 278; 2nd col., The Algorithm, Step 4; p. 279, Figs. 3-4).

In regard to claim 2 and 22, Schmidt further discloses the claimed situation where equation (1) on p. 276 is equivalent the equation in the claim.

In regard to claims 3, 8, 23, 28, and 42, Schmidt further discloses said determining of a first plurality of directions of arrival for the signals comprises determining angles 1 to L is based at least in part on $\mathbf{a}(1...J)$ intersecting with a subspace spanned by the first $\mathbf{x}(t)$ (p. 277, 1st col., 2nd ¶).

In regard to claims 4-7 and 24-27, Schmidt further discloses the claimed orthonormal vectors (col. 20, lined 40-48).

12. Claims 1-9, 8, 21-23, 28, 42, and 49-50 are rejected under 35 U.S.C. 102(b) as being anticipated by Roy (US 4,965,732 A).

In regard to claims 1, 21, 41, and 49-50, Roy discloses receiving a first plurality of signals wirelessly transmitted by a plurality of signal sources, employing a plurality of sensors (col. 4, lines 8-39; col. 7, line 67 to col. 8, line 1); taking a first sample of the received signals sensed by the sensors; constructing a first received signal vector (col. 8, line 62, equations (2), \mathbf{x} , \mathbf{y}) based on the first sample, employing a first plurality of signal directional vectors (\mathbf{A}); and determining a first plurality of directions of arrival for the signals based at least in part on a relationship between the first received signal vector and the first

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plurality of signal directional vectors (col. 4, lines 25-35; col. 9, lines 38-44; col. 12, lines 26-43).

In regard to claim 2 and 22, Roy further discloses the claimed situation where col. 8, line 62, equations (2) is equivalent the equation in the claim.

In regard to claims 3, 8, 23, 28, and 42, Roy further discloses said determining of a first plurality of directions of arrival for the signals comprises determining angles 1 to L is based at least in part on $\mathbf{a}(1...J)$ intersecting with a subspace spanned by the first $\mathbf{x}(t)$ (col. 10, lines 33-44).

In regard to claims 11, 31, 45, and 51-52, Roy further discloses receiving a plurality of signals wireless transmitted by a plurality of signal sources, employing a plurality of sensors; determining a first plurality of directions of arrival for a first plurality of multipaths of a first of the signals; and obtaining the first received signal based at least in part on the determined first plurality of directions of arrival for the first plurality of multipaths of the first signal (col. 15, lines 51-61).

In regard to claim 13, 33, and 47, Roy further discloses determining a correlation matrix for the signals, and determining a plurality of eigenvectors of the correlation matrix corresponding to the signals; and said determining of the first plurality of directions of arrivals for the signals, including the direction of arrival of the first signal, is performed based at least in part on the determined eigenvectors of the correlation matrix corresponding to the signals (col. 11, line 2 to col. 12, line 25).

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13. Claims 1-3, 8, 21-23, 28, 41, 42, and 49-50 are rejected under 35 U.S.C. 102(b) as being anticipated by IDS document Ermolaev.

In regard to claims 1, 21, 41, and 49-50, Ermolaev discloses receiving a first plurality of signals wirelessly transmitted by a plurality of signal sources, employing a plurality of sensors (p. 2389, II, 1st sentence); taking a first sample of the received signals sensed by the sensors; constructing a first received signal vector (\mathbf{r} , equation (1a)) based on the first sample, employing a first plurality of signal directional vectors (\mathbf{A}); and determining a first plurality of directions of arrival for the signals based at least in part on a relationship between the first received signal vector and the first plurality of signal directional vectors (p. 2390, III, 1st ¶; Figs. 1-4).

In regard to claim 2 and 22, Ermolaev further discloses the claimed situation where p. 2389, equation (1a) is equivalent to the equation in the claim.

14. Claims 1-3, 8, 21-23, 28, 41, 42, and 49-50 are rejected under 35 U.S.C. 102(b) as being anticipated by Paulraj.

In regard to claims 1, 21, 41, and 49-50, Paulraj discloses receiving a first plurality of signals wirelessly transmitted by a plurality of signal sources, employing a plurality of sensors (p. 59, Reverse-Link Space-Time Signal Processing); taking a first sample of the received signals sensed by the sensors; constructing a first received signal vector (p. 64, x, equation (56)) based on the first sample, employing a first plurality of signal directional vectors (\mathbf{A}); and determining a first plurality of directions of arrival for the signals based at least in

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part on a relationship between the first received signal vector and the first plurality of signal directional vectors (p. 64, 2nd col., first full ¶).

In regard to claim 2 and 22, Paulraj further discloses the claimed situation where equation (56) on p. 64 is equivalent the equation in the claim.

In regard to claims 3, 8, 23, 28, and 42, Paulraj further discloses said determining of a first plurality of directions of arrival for the signals comprises determining angles 1 to L is based at least in part on $a(1...J)$ intersecting with a subspace spanned by the first $x(t)$ (p. 64, ¶ including equation (57), and the following ¶).

15. Claims 1, 11, 21, 31, 41, 45, and 49-52 are rejected under 35 U.S.C. 102(b) as being anticipated by Vanderveen.

In regard to claims 1, 21, 41, and 49-50, Vanderveen discloses receiving a first plurality of signals wirelessly transmitted by a plurality of signal sources, employing a plurality of sensors (abstract); taking a first sample of the received signals sensed by the sensors; constructing a first received signal vector (p. 1250, x, equation (3)) based on the first sample, employing a first plurality of signal directional vectors (A); and determining a first plurality of directions of arrival for the signals based at least in part on a relationship between the first received signal vector and the first plurality of signal directional vectors (p. 1251, 2nd col., ¶ following equation (9)).

In regard to claims 11, 31, 45, and 51-52, Vanderveen further discloses receiving a plurality of signals wireless transmitted by a plurality of signal

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sources, employing a plurality of sensors; determining a first plurality of directions of arrival for a first plurality of multipaths of a first of the signals; and obtaining the first received signal based at least in part on the determined first plurality of directions of arrival for the first plurality of multipaths of the first signal (p. 1250, section 2).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

16. Claims 4, 9-11, 13-20, 24, 29-31, 33-40, 43-45, 47-48, and 51-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over IDS document Schmidt.

In regard to claims 4 and 24, Schmidt discloses X is the received signal vector (p. 276, 2nd col., The Data Model, 1st ¶). While Schmidt doesn't explicitly disclose the claimed steps, it is well known that dividing a vector (X) with magnitude and direction by a value equal to a magnitude operation ($\| \ \|$) on that vector ($\|X\|$), will give the direction of the vector with unit magnitude.

In regard to claims 9, 29, and 43, it is well known that to track objects over time, and thus repeating the direction finding procedure a second and subsequent times.

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In regard to claims 11, 31, 45, and 51-52, Schmidt discloses his invention applies to multiple wavefronts arriving at an antenna array (p. 276, Introduction, 1st ¶). The invention is not limited to one single per source. It is well known that in many practical situations, multipath signals are present. It would have been obvious to use Schmidt's method of determining the direction of signals to determine the direction from signals when some of those signals are multipath signals.

In regard to claim 13, 33, and 47, Schmidt further discloses determining a correlation matrix for the signals, and determining a plurality of eigenvectors of the correlation matrix corresponding to the signals; and said determining of the first plurality of directions of arrivals for the signals, including the direction of arrival of the first signal, is performed based at least in part on the determined eigenvectors of the correlation matrix corresponding to the signals (p. 277, section "The S Matrix" to the section "The Signal and Noise Subspaces").

In regard to claims 10, 14, 30, 34, 44, and 48, it is well known to average multiple measurements in order to "average out" random uncertainties and increase the accuracy of the measurement.

In regard to claims 15-20, and 35-40, it would have been obvious to model the transmitted signal as a signal with the properties of an electromagnetic wave, because that is the type of waves received by antenna arrays.

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17. Claims 11, 13-20, 24, 29-31, 33-40, 43-45, 47-48, and 51-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over IDS document Schmidt, as described above, and in further view of one of Edman and Krim.

Edman (p. 25, section 6.2.1) and Krim (p. 75-76, Coherent Signals) discloses that MUSIC can be modified, using overlapping subarrays, to handle correlated signals. It would have been obvious to modify Schmidt in this matter because each explicitly teaches modifying Schmidt's MUSIC algorithm.

18. Claims 9-10, 14-20, 29-30, 34-40, 43-44, and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Roy (US 4,965,732 A).

In regard to claims 9, 29, and 43, it is well known that to track objects over time, and thus repeating the direction finding procedure a second and subsequent times.

In regard to claims 10, 14, 30, 34, 44, and 48, it is well known to average multiple measurements in order to "average out" random uncertainties and increase the accuracy of the measurement.

In regard to claims 15-20, and 35-40, it would have been obvious to model the transmitted signal as a signal with the properties of an electromagnetic wave, because that is the type of waves received by antenna arrays.

19. Claims 9-11, 13-20, 29-31, 33-40, 43-45, 47-48, and 51-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over IDS document Ermolaev.

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In regard to claims 9, 29, and 43, it is well known that to track objects over time, and thus repeating the direction finding procedure a second and subsequent times.

In regard to claims 11, 31, 45, and 51-52, Ermolaev discloses his invention applies to multiple wavefronts arriving at a sensor array (p. 2389, II, 1st ¶). The invention is not limited to one single per source. It is well known that in many practical situations, multipath signals are present. It would have been obvious to use Ermolaev's method of determining the direction of signals to determine the direction from signals when some of those signals are multipath signals.

In regard to claim 13, 33, and 47, Ermolaev further discloses determining a correlation matrix for the signals, and determining a plurality of eigenvectors of the correlation matrix corresponding to the signals; and said determining of the first plurality of directions of arrivals for the signals, including the direction of arrival of the first signal, is performed based at least in part on the determined eigenvectors of the correlation matrix corresponding to the signals (p. 2390, 1st ¶).

In regard to claims 10, 14, 30, 34, 44, and 48, it is well known to average multiple measurements in order to "average out" random uncertainties and increase the accuracy of the measurement.

In regard to claims 15-20, and 35-40, it would have been obvious to model the transmitted signal as a signal with the properties of an electromagnetic wave, because that is the type of waves received by antenna arrays.

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Allowable Subject Matter

20. Claim(s) 12, 32, and 46 would be allowable if rewritten to overcome the objection(s) set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

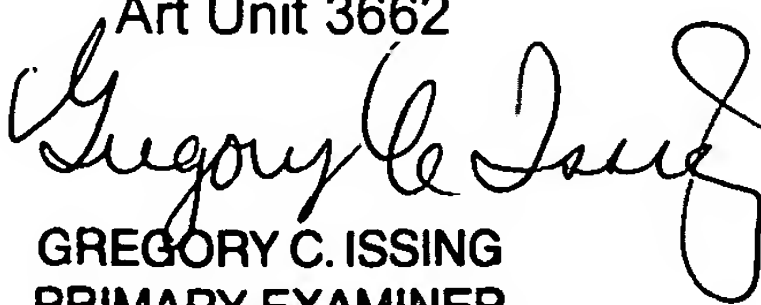
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fred H. Mull whose telephone number is 703-305-1250. The examiner can normally be reached on M-F 9:00 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas H. Tarcza can be reached on 703-360-4171. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

fhm

Fred H. Mull
Examiner
Art Unit 3662


GREGORY C. ISSING
PRIMARY EXAMINER